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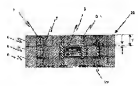
(54) CAPACITOR ELEMENT AND MULTILAYER WIRING BOARD CONTAINING CAPACITOR ELEMENT



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a capacitor element and multilayer wiring board containing the capacitor element which are down-sized and has a low inductance.

SOLUTION: The capacitor element 5 has lead-out electrodes 4 in which conductors are filled into a plurality of throughholes 3 penetrating in a vertical direction to many electrode layers 1, and the lead-out electrodes 4 extrude outside the base surfaces of the capacitor element 5. The multilayer wiring board 11 contains the capacitor element 5, and the lead-out electrodes 4 are connected to connecting pads 9 through penetrating conductors 8 on both upper/ lower main surfaces of the capacitor element 5.

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CLAIMS

[Claim(s)]

[Claim 1] It is the capacitor element characterized by being the capacitor element which has the drawer polar zone which carries out the laminating of many electrode layers and ceramic dielectric layers by turns, changes, and two or more through tubes perpendicularly penetrated to the electrode layer of said large number are filled up with a conductor, and changes, and having projected said drawer polar zone on the outside of the principal plane of said capacitor element.

[Claim 2] A conductor is formed. while carrying out the laminating of two or more insulating layers which consist of an organic material -- the front face of these insulating layers -- wiring -- Through a conductor, connect electrically and it changes. said wiring located up and down on both sides of said insulating layer -- a conductor -- the penetration formed in said insulating layer in between -- said wiring located in the up-and-down outermost layer -- it considering as the connection pad by which some conductors are connected with an external electrical circuit, and, while building a capacitor element according to claim 1 in the interior of the cavernous section which said insulating layer was further alike at least, and was prepared vertical both the principal planes of this capacitor element -- setting -- said drawer polar zone -- said penetration -- the multilayer-interconnection substrate with a built-in capacitor element characterized by connecting with said connection pad electrically through a conductor.

[Translation done.]

* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the wiring substrate which contained the capacitor element and it which are used for electronic equipment, such as various AV equipments, a household-electric-appliances device, communication equipment and a computer, and its peripheral device.

[0002]

[Description of the Prior Art] A conductor is formed. wiring of plurality [front face / which consist of organic resin ingredients, such as an insulating layer or a glass epoxy resin with which a wiring substrate consists of ceramic ingredients, such as an alumina, conventionally, / of an insulating layer / the interior and the front face] -- Through a conductor, connect electrically and it changes. wiring located up and down -- a conductor -- the penetration which formed between in the insulating layer -- while carrying out loading attachment of the electronic devices, such as a semiconductor device, and a capacitor, a resistance element, on the front face of this wiring substrate -- these electrodes -- each wiring -- the electronic instrument used for electronic equipment is formed by connecting with

a conductor.

[0003] However, small and thin shape, and lightweight-ization is required as electronic equipment being represented by mobile communication equipment, and small and densification are increasingly required also for the wiring substrate carried in such electronic equipment in recent years.

[0004] Since it corresponds to such a demand, mounting a chip-like capacitor element in the interior of a wiring substrate is proposed by JP,11-220262,A in order to reduce the number of the electronic devices carried in the front face of a wiring substrate and to miniaturize a wiring substrate.

[0005]

[Problem(s) to be Solved by the Invention] While the further miniaturization of electronic equipment is required in recent years, the capacitor element nearby miniaturization built in a wiring substrate with the miniaturization of a wiring substrate is required increasingly.

[0006] however, a chip-like capacitor element as shown in JP,11-220262,A -- a wiring substrate -- building -- wiring inside a wiring substrate -- a conductor or penetration, in order to make electric connection with a conductor Although it is necessary to form in the top face and/or inferior surface of tongue of a capacitor element the surface electrode which consists of solder or a conductive paste by approaches, such as screen printing Forming a detailed surface electrode with the miniaturization of a capacitor element changed with difficulty, and the miniaturization of the capacitor element for wiring substrate built-in had the trouble of being difficult.

[0007] furthermore, wiring whose electronic equipment, such as communication equipment, a frequency is used in high frequency field several 100MHz or more, and connects the electrode of a capacitor element, and electronic parts, such as a semiconductor device, in such a high frequency field in recent years with improvement in the speed of transmission speed -- it is becoming impossible to disregard the inductance component resulting from the die length of a conductor When a chip-like capacitor element is built in a wiring substrate, for this reason,

the electrode drawer from each electrode layer of a capacitor element to the end-face electrode of a capacitor element side face, Since there is furthermore leading about of electrodes, such as a top face of a capacitor element and/, or an electrode drawer to an inferior surface of tongue, The inductance component resulting from the die length of a leading-about electrode will become big. deltaV=L-dI/dt (deltaV -- a power-source noise and L -- an inductance and I -- a current value --) t became so large that power-source noise deltaV generated by the inductance component defined by time amount cannot be disregarded, and had the trouble of making electronic equipment, such as communication equipment, generate malfunction etc.

[0008] This invention is thought out in view of the trouble of this conventional technique, and the purpose has little generating of a noise and is to offer the small capacitor element and the multilayer-interconnection substrate with a built-in capacitor element which do not make electronic equipment, such as communication equipment, generate malfunction.

[0009]

[Means for Solving the Problem] It is the capacitor element which has the drawer polar zone which the capacitor element of this invention carries out the laminating of many electrode layers and ceramic dielectric layers by turns, and changes, and two or more through tubes perpendicularly penetrated to many electrode layers are filled up with a conductor, and changes, and the drawer polar zone is characterized by having projected on the outside of the principal plane of this capacitor element.

[0010] Moreover, the multilayer-interconnection substrate with a built-in capacitor element of this invention A conductor is formed. while carrying out the laminating of two or more insulating layers which consist of an organic material -- the front face of these insulating layers -- wiring -- Through a conductor, connect electrically and it changes. wiring located up and down on both sides of an insulating layer -- a conductor -- the penetration formed in the insulating layer in between -- wiring located in the up-and-down outermost layer -- it considering as

the connection pad by which some conductors are connected with an external electrical circuit, and, while building the above-mentioned capacitor element in the interior of the cavernous section which the insulating layer was further alike at least, and was prepared vertical both the principal planes of this capacitor element -- setting -- pulling out -- the polar zone -- penetration -- it is characterized by connecting with a connection pad electrically through a conductor.

[0011] Since it shall have the drawer polar zone which the through tube which penetrates a capacitor element perpendicularly to many electrode layers is filled up with a conductor, and changes according to the capacitor element of this invention, and a diameter can form easily the detailed drawer polar zone of several 10 micrometers, without printing an end-face electrode and a surface electrode to a capacitor element, it can miniaturize. Moreover, since had to take about an electrode, it did not have to be carried out [the end-face electrode and the surface electrode could be arranged in the capacitor element,], it could pull out by the minimum distance right above [of an electrode layer] and the polar zone was formed, it should be possible to have made small the inductance component resulting from the die length of a leading-about electrode, and it should excel in the electrical property with few power-source noises also in the RF field. Furthermore, since the drawer polar zone has projected on the outside of the principal plane of a capacitor element according to the capacitor element of this invention When a capacitor element is built in a multilayer-interconnection substrate and a multilayer-interconnection substrate with a built-in capacitor element is manufactured, it sets at the pressurization process. It becomes possible to raise pack density. the penetration which was projected on the outside of the principal plane of a capacitor element and to which it pulled out and the polar zone was formed in the insulating layer -- a conductor -- pressurizing -- penetration -- the conductor of a conductor -- penetration -- the electric resistance of a conductor is decreased -- it can make -- consequently, penetration -- the inductance component of a conductor can be made small,

there is little generating of a noise, and electronic equipment, such as communication equipment, is not made to generate malfunction

[0012] moreover, from having built the above-mentioned capacitor element in the interior of the cavernous section which the insulating layer was further alike at least, and was prepared according to the multilayer-interconnection substrate with a built-in capacitor element of this invention Since a capacitor element haves to arrange neither an end-face electrode nor a surface electrode like the conventional capacitor element and does not have to take about and carry out an electrode It becomes possible to realize low inductance-ization from the multilayer-interconnection substrate which contained the conventional capacitor element, and there is little generating of a noise and it can consider as the multilayer-interconnection substrate with a built-in capacitor element which does not make electronic equipment, such as communication equipment, generate malfunction.

[0013] It considers as the connection pad by which some conductors are connected with an external electrical circuit. furthermore, wiring which is located in the up-and-down outermost layer according to the multilayer-interconnection substrate with a built-in capacitor element of this invention -- vertical both the principal planes of a capacitor element -- setting -- pulling out -- the polar zone -- penetration, since it was made to connect with a connection pad electrically through a conductor and becomes possible to connect an external electrical circuit with a capacitor element electrically by the minimum distance The inductance resulting from the die length of wiring can be reduced, and the effectiveness of noise reduction can consider as a large multilayer-interconnection substrate with a built-in capacitor element.

[0014]

[Embodiment of the Invention] Next, the capacitor element of this invention and a multilayer-interconnection substrate with a built-in capacitor element are explained to a detail based on an attached drawing.

[0015] Drawing 1 is the sectional view showing an example of the gestalt of

operation of the capacitor element of this invention. Moreover, drawing 2 is the sectional view of the multilayer-interconnection substrate with a built-in capacitor element of this invention which built in the capacitor element of drawing 1 , and shows the case where one capacitor element is built in, by this example. In these drawings, for 1, as for a ceramic dielectric layer and 3, an electrode layer and 2 are [a through tube and 4] drawer polar zone, and the capacitor element 5 of this invention mainly consists of these. 6 [moreover,] -- an insulating layer and 7 -- wiring -- a conductor and 8 -- penetration -- a conductor and 9 are connection pads and the multilayer-interconnection substrate 11 with a built-in capacitor element of this invention mainly consists of these and a capacitor element 5. In addition, the multilayer-interconnection substrate 11 with a built-in capacitor element which carries out the three-layer laminating of the insulating layer 6 to drawing 2 , and grows into it is shown. Moreover, the cavernous section 10 is formed in at least one layer of an insulating layer 6 by which the multilayer-interconnection substrate 11 with a built-in capacitor element is located in the interior, and the capacitor element 5 is laid under the cavernous section 10.

[0016] Length, width, and height are the rectangular parallelepipeds which are 0.3-5mm, respectively, and the capacitor element 5 is formed by carrying out the laminating of the ceramic dielectric layer 2 and the electrode layer 1 to drawing 1 by turns, as shown in a sectional view.

[0017] As an ingredient of such a ceramic dielectric layer 2, various dielectric ceramic ingredients can be used, for example, it is calcium about Ba which is the ceramic constituent of BaTiO3, or a LaTiO3, CaTiO3 and SrTiO3 grade, or the configuration element of BaTiO3, and barium titanate system ingredients, such as the solid solution which permuted Ti partially by Zr or Sn, a lead system perovskite type structure compound, etc. are mentioned.

[0018] Moreover, as an ingredient which forms the electrode layer 1, metals and those alloys, such as Pd and Ag-Pt-nickel-Cu-Pb, are used, for example.

[0019] Furthermore, the capacitor element 5 has the drawer polar zone 4 which the through tube 3 perpendicularly penetrated to many electrode layers 1 is filled

up with a conductor, and changes.

[0020] From having the drawer polar zone 4 which the through tube 3 which penetrates a capacitor element 5 perpendicularly to many electrode layers 1 is filled up with a conductor, and changes according to the capacitor element 5 of this invention Since a diameter can form easily the detailed drawer polar zone 4 of several 10 micrometers, without printing an end-face electrode and a surface electrode to a capacitor element 5, while being able to miniaturize a capacitor element 5 Since have to take about an electrode, it is not necessary for an end-face electrode and a surface electrode to be arranged in a capacitor element 5, and to carry out it, it can pull out by the minimum distance right above [of the electrode layer 1] and the polar zone 4 can be formed It should be possible to have made small the inductance component resulting from the die length of a leading-about electrode, and it should excel in the small electrical property of a power-source noise also in the RF field.

[0021] In addition, the number of the drawer polar zone 4 is 4-50, and these are classified into the 1st drawer polar zone and the 2nd drawer section. And the electrode layer 1 which constitutes a capacitor element 5 is also classified into the 1st electrode layer and the 2nd electrode layer, and the 1st electrode layer is electrically connected by the 1st drawer electrode. Moreover, the 2nd drawer electrode connects electrically, and the 2nd electrode layer is arranged so that it may counter with the 1st electrode layer through the ceramic dielectric layer 2.

[0022] When such drawer polar zone 4 has the inclination for the effectiveness of reducing an inductance as the number is less than four pieces to become small and it exceeds 50 pieces, it has the inclination for the area of the electrode layer 1 to become small and for the capacity of a capacitor element 5 to become small.

[0023] Moreover, it is important in order for making it the 1st drawer polar zone and the 2nd drawer polar zone adjoin each other to reduce an inductance, and when the 1st drawer polar zone and the 2nd drawer polar zone arrange so that it may be located at the lattice point when a grid-like array adjoins, respectively, arrangement of the drawer polar zone 4 can reduce an inductance more, and is

desirable.

[0024] Furthermore, spacing of drawer polar-zone 4 adjoining comrades is 50-400 micrometers. There is a danger of short-circuiting in case it will be filled up with conductive paste, if smaller than 50 micrometers, and when larger than 400 micrometers, there is an inclination for the effectiveness of inductance reduction to become small.

[0025] As for the through tube 3 formed in such a capacitor element 5, it is desirable to be formed in the layered product which consists of the electrode layer 1 and the ceramic dielectric layer 2 by approaches, such as laser drilling processing by punching processing and UV-YAG laser by punching, excimer laser, carbon dioxide gas laser, etc., and to be formed of drilling processing by laser, in order to consider as the detailed through tube 3 especially. Moreover, what is necessary is for the path of a through tube 3 to be several 10 micrometers - several mm, and just to decide it suitably in accordance with the magnitude of a capacitor element 5.

[0026] In addition, a through tube 3 may perform ultrasonic-cleaning processing, DESUMIA processing, etc. after punching processing or laser drilling processing, in order to make good electrical installation of the conductor and the electrode layer 1 with which the interior is filled up.

[0027] Moreover, it is desirable to contain the thing of the same quality of the material as the electrode layer 1 from a viewpoint of metals and those alloys, such as Pd and Ag-Pt-nickel-Cu-Pb, being used, and making good especially electrical installation with the electrode layer 1 as a conductor with which a through tube 3 is filled up.

[0028] The conductor with which such a through tube 3 is filled up is formed by filling up into a through tube 3 the conductive paste which is made to distribute metal powder and changes in the organic vehicle made to dissolve organic binder resin in an organic solvent with approaches, such as screen printing. In addition, in a vehicle, various dispersants, activators, plasticizers, etc. besides these may be added if needed.

[0029] Moreover, the organic binder resin used for conductive paste has the role which gives proper viscosity and a proper rheology in the embedding to a through tube 3 while making homogeneity distribute metal powder, for example, acrylic resin, phenol resin, an alkyd resin, rosin ester ethyl cellulose methyl cellulose, PVA (polyvinyl alcohol), polyvinyl butyrate, etc. are mentioned. It is desirable to use acrylic resin from a viewpoint of improving dispersibility of metal powder especially.

[0030] Furthermore, as for the organic solvent used for conductive paste, it is desirable to dissolve organic binder resin, to distribute a metal powder particle, and for an ester system, naphtha, etc., such as alcoholic systems, such as nothing, for example, alpha-terpineol, and benzyl alcohol, a hydrocarbon system and an ether system, and BCA (butyl carbitol acetate), to be used in the role which makes such whole mixed stock the shape of a paste, and to use alcohols solvents, such as alpha-terpineol, from a viewpoint of improving dispersibility of metal powder especially.

[0031] Conductive paste can be considered as the paste which added the glass frit and the ceramic frit further again, in order to raise the bond strength to the capacitor porcelain after embedding and baking. It is not limited especially as the glass frit or ceramic frit in this case, and titanium system oxides, such as glass of a hoe silicate system or a hoe silicic acid zinc system or titania barium titanate, etc. can be used suitably.

[0032] Such a capacitor element 5 is manufactured by the following approach.

[0033] First, nickel metal paste created by the well-known paste creating method is printed on a BaTiO3 dielectric ceramic green sheet front face so that it may change with a predetermined configuration with screen printing, a non-calcinated electrode layer is formed in it, continuously, the laminating of these is carried out to predetermined sequence, they are stuck [it changes with the ceramic dielectric layer 2 created by the well-known sheet forming method, for example,] to it by pressure, and a layered product is obtained. And to this layered product, the two or more through tubes 3 formation-back is rinsed to a position with laser,

a through tube 3 is rinsed by ultrasonic cleaning, and it is filled up with the conductive paste which changes from for example, nickel metal powder, acrylic resin, and alpha-terpineol to this through tube 3 with screen printing. It is manufactured by calcinating these at the temperature of 800-1600 degrees C after an appropriate time.

[0034] In addition, the organic binder resin after baking and a solvent are removed, and the conductor with which the through tube 3 was filled up changes with the drawer polar zone 4.

[0035] Moreover, it is characterized by having projected this drawer polar zone 4 on the outside of the principal plane of a capacitor element 5 at this invention, and this is important in this invention.

[0036] From according to the capacitor element 5 of this invention, having pulled out to capacitor element 5 principal plane, and having made the polar zone 4 project When the capacitor element 5 was built in the multilayer-interconnection substrate and the multilayer-interconnection substrate 11 with a built-in capacitor element is manufactured, the penetration formed in the insulating layer 6 in the pressurization process at the time of multilayer-interconnection substrate with built-in capacitor element 11 production, when a pressure cuts to a conductor 8 at homogeneity penetration -- the conductor of a conductor 8 -- it becomes possible to raise pack density and electric resistance is decreased -- it can make -- consequently, penetration -- the inductance component of a conductor 8 can be made small, there is little generating of a noise, and electronic equipment, such as communication equipment, is not made to generate malfunction

[0037] As for such drawer polar zone 4, it is desirable that it considers as the range of 0.1t-0.5t when height T of the part projected on the outside of the principal plane of a capacitor element 5 sets thickness of an insulating layer 6 to t. it projected -- it pulls out and height T of the polar zone 4 is less than 0.1t -- penetration -- since sufficient pressure for a conductor 8 is not applied -- a conductor -- the effectiveness of raising pack density -- small -- becoming -- penetration -- it is in the inclination for the inductance of a conductor 8 to become

large. moreover, the time of carrying out the laminating of the insulating layer 6, and pressurizing it, if it exceeds 0.5t -- penetration -- a pressure is applied to a conductor 8 too much, and there is an inclination which curvature generates in the multilayer substrate 11 with a built-in capacitor. Therefore, it pulls out, and when [whose height T of the lobe of the polar zone 4 set thickness of an insulating layer 6 to t] the outside of the principal plane of a capacitor element 5 is made to project, the range of 0.1t-0.5t is desirable [T].

[0038] moreover, the penetration which was projected on the outside of capacitor element 5 principal plane and which pulled out and formed the diameter of the cross section of a direction parallel to the insulating layer 6 of the polar zone 4 in the insulating layer 6 -- it is desirable that it is larger than the diameter of a conductor 8. penetration -- the time of carrying out the laminating of the insulating layer 6, and pressurizing it by making it larger than the diameter of a conductor 8, -- penetration -- since a pressure is applied to a conductor 8 at homogeneity -- penetration -- the consistency of a conductor 8 can go up and electric resistance can be decreased.

[0039] As an approach of pulling out on the outside of the principal plane of such a capacitor element 5, and making the polar zone 4 projecting A through tube 3 is formed in the ceramic green sheet layered product before the ceramic dielectric layer 2 and baking which changes. After filling up with and pulling out a metallic conductor and forming the polar zone 4 in this through tube 3, before calcinating these, by performing roughening processing according the surface part of ceramic green sheet layered products other than drawer polar-zone 4 to brushing Or it can pull out by irradiating laser on a ceramic green sheet layered product front face, and removing a part of ceramic green sheet front face, and the polar zone 4 can be made to project. Or after forming a through tube 3 in a ceramic green sheet layered product, by placing the mask which has the thickness of the request by which opening of the part of a through tube 3 was carried out to the ceramic green sheet front face, and filling up a through tube 3 with a metallic conductor using a squeegee etc. from on the, the drawer polar

zone 4 equivalent to the thickness of a mask may be made to project, and you may form by finally calcinating these. Furthermore, after sticking protective coats, such as a resin film, on a ceramic green sheet layered product front face, it can also form by calcinating having formed the through tube 3, filling up this through tube 3 with a metallic conductor from on a protective coat, and stripping off a protective coat after an appropriate time, or attaching a protective coat. Ceramic dielectric layer 2 part of the front face of the capacitor element 5 after baking may be removed by the chemical technique, such as etching, and the drawer electrical-and-electric-equipment polar zone 4 may be made to project further again.

[0040] in addition -- although the triangle in which the hemicycle, the polygon, or the point sharpened [the cross section of a direction perpendicular to an insulating layer 6] is sufficient as the configuration of the lobe of the drawer polar zone 4 -- the point of the drawer polar zone 4, and penetration -- as for the cross-section configuration of the drawer polar zone 4, from a viewpoint of making the touch area of a conductor 8 increasing and making firm adhesion with an insulating layer 6 and a capacitor element 5, it is desirable that it is a hemicycle. it projected by considering as such a hemicycle -- pulling out -- the polar zone 4 and penetration -- a touch area with a conductor 8 -- increasing -- consequently, the capacitor element 5 -- penetration -- being restrained by the conductor 8 -- the drawer polar zone 4 and penetration -- it does not exfoliate and disconnect between conductors 8

[0041] As an approach of controlling the form of the lobe of such drawer polar zone 4, a through tube 3 is formed in a ceramic green sheet layered product, and the configuration of the mask at the time of filling up a through tube 3 with a metallic conductor can be adjusted, or it can adjust by grinding the lobe front face of the drawer polar zone 4 after baking.

[0042] Next, the multilayer-interconnection substrate 11 with a built-in capacitor element of this invention is explained to a detail based on drawing 2 and drawing 3 . In addition, drawing 3 (a) - (g) is a sectional view for every process for

manufacturing the multilayer-interconnection substrate 11 with a built-in capacitor element of drawing 2 .

[0043] First, as shown to drawing 3 (a) in a sectional view, precursor sheet 6a which is not hardened [an insulating layer 6 and / which change] is prepared, and the through tube 12 whose diameter is about 17-150 micrometers is drilled in a desired part by laser beam machining at this precursor sheet 6a.

[0044] Non-hardened precursor sheet 6a consists of organic resin ingredients, such as an epoxy resin, and bismaleimide triazine resin, thermosetting polyphenylene ether resin, liquid crystal polymer resin. Coupling agents, such as a silane system for raising a mechanical strength, and a titanate system, Light stabilizer, such as an ultraviolet ray absorbent for improving the antioxidant and lightfastness for improving thermal stability, Fire-resistant assistants, such as a fire-resistant agent of the halogen system for improving fire retardancy, or a phosphoric-acid system, an antimony system compound, and boric-acid zinc, metaboric acid barium, a zirconium dioxide, Lubricant, such as a higher fatty acid for improving lubricity, and higher-fatty-acid ester, a higher-fatty-acid metal salt, a fluorocarbon system surfactant, In order to adjust a coefficient of thermal expansion And/or, a mechanical strength The aluminum oxide, the oxidization silicon, the titanium oxide, the barium oxide, the strontium oxide and the zirconium dioxide, the calcium-oxide zeolite, the silicon nitride and alumimium nitride, the silicon carbide, and boric-acid ARUMINIU for making it improve Base materials, such as a nonwoven fabric which consists of glass fabrics etc. and the heat-resistant organic resin fiber which wove fillers, such as MU stannic-acid barium zirconic acid barium zirconic acid strontium, or fibrous glass into blanket-like, may be made to contain.

[0045] Such precursor sheet 6a is manufactured by the following approaches, when using the composite material of thermosetting resin and inorganic insulation powder as an insulating material. First, the mixture which added thermosetting resin to the inorganic insulation powder mentioned above with the solvent so that the amount of inorganic insulation powder might become with 17 -

80 volume % is obtained, this mixture is mixed with the means of a kneading machine (kneader), 3 rolls, etc., and a paste is manufactured. And after adopting sheet forming methods, such as the rolling-out method, and an extrusion process, a radiation method, a doctor blade method, and fabricating this paste in the shape of a sheet, when thermosetting resin heats and dries to the temperature which does not carry out full hardening, precursor sheet 6a used as an insulating layer 6 is manufactured. In addition, a paste is a fluid which has suitably the predetermined viscosity which comes to add solvents, such as toluene and butyl acetate, and methyl-ethyl-ketone methanol methyl-cellosolve acetate isopropyl alcohol methyl-isobutyl-ketone dimethylformamide, to the composite material of thermosetting resin and inorganic insulation powder, and although the viscosity is based also on a sheet forming method, 100-3000poise is desirable [viscosity].

[0046] next, the conductive paste which consists of copper, silver, gold, solder, etc. in a through tube 12 as shown to drawing 3 (b) in a sectional view -- the former -- well-known screen printing etc. -- adopting -- being filled up -- penetration -- a conductor 8 is formed.

[0047] next, wiring put on the front face and rear face of a precursor sheet as shown to drawing 3 (c) in a sectional view -- a conductor 7 is prepared. and a sectional view shows to drawing 3 (d) -- as -- wiring -- a conductor 7 -- wiring required for the front face and rear face of a precursor sheet -- a conductor 7 and penetration -- it piles up and imprints so that a conductor 8 may connect electrically.

[0048] in addition -- this example -- wiring -- formation of a conductor 7 -- a replica method -- carrying out -- **** -- such wiring -- a conductor 7 is formed by the approach described below. first, the etching-resist removal after forming a resist layer so that a metallic foil with a thickness of 1-35 micrometers it is thin from one sort or two sorts or more of alloys chosen from copper, gold, silver, aluminum, etc. may be pasted up on the front face of the base materials 13, such as a mold release sheet, and it may become the mirror image pattern of a desired circuit pattern on the front face -- wiring of the mirror image of a

predetermined circuit pattern -- a conductor 7 is formed. next, wiring -- covering to the front face and rear face of precursor sheet 6a of a conductor 7 -- wiring -- after a pressure carries out pressurization heating of the base material 13 with which the conductor 7 was formed superposition and after an appropriate time to the front face and rear face of precursor sheet 6a on the conditions 0.5 - 10MPa and whose temperature are 60-150 degrees C, by removing a base material 13 shows to a sectional view at drawing 3 (e) -- as -- wiring -- a conductor 7 is put on a precursor sheet. in addition, this time -- penetration -- what is considered as the condition which has not been hardened completely of not hardening is important for a conductor 8.

[0049] Moreover, as a base material 13, well-known things, such as polyethylene terephthalate, and polyethylenenaphthalate polyimide polyphenylene sulfide, vinyl chloride polypropylene, can be used. 10-100 micrometers is suitable for the thickness of a base material 13, and its 25-50 micrometers are desirably good. wiring formed by a base material 13 bending [deformation or] as the thickness of a base material 13 is less than 10 micrometers -- a conductor 7 -- disconnecting -- being easy -- if thickness exceeds 100 micrometers, the flexibility of a base material 13 will be lost, and there is an inclination for exfoliation of the base material 13 from a precursor sheet to become difficult. Moreover, in order to form an electrolysis metallic foil in base material 13 front face, well-known adhesives, such as acrylic, and a rubber system, a silicon system, an epoxy system, may be used.

[0050] And two or more precursor sheet 6a manufactured through the process of above-mentioned (a) - (f) as shown to drawing 3 (f) in a sectional view, The laminating of the precursor sheet is carried out. a capacitor element 5 -- preparing -- next, the point of the drawer polar zone 4 and penetration, while laying by performing alignment with a conductor 8 The multilayer-interconnection substrate 11 with a built-in capacitor element of this invention shown in drawing 3 (g) with a sectional view is completed by temperature's carrying out at 150-300 degrees C, and a pressure's carrying out a hotpress on condition that 0.5-10MPa

for 30 minute - 24 hours, and carrying out full hardening of a precursor sheet and the conductive paste.

[0051] In addition, what is necessary is just to drill it in the part in which the capacitor element 5 of precursor sheet 6a is held by laser or the punching method, before the cavernous section 10 which holds a capacitor element 5 carries out the laminating of the precursor sheet 6a.

[0052] in this way from having built the above-mentioned capacitor element 5 in the interior of the cavernous section 10 which the insulating layer 6 was further alike at least, and was prepared according to the multilayer-interconnection substrate 11 with a built-in capacitor element of this invention It becomes possible to realize low inductance-ization from the multilayer-interconnection substrate which contained the capacitor element by which the electrode was printed by the conventional end face. There is little generating of a noise and it can consider as the multilayer-interconnection substrate 11 with a built-in capacitor element which does not make electronic equipment, such as communication equipment, generate malfunction.

[0053] It considers as the connection pad 9 by which some conductors 7 are connected with an external electrical circuit. moreover, wiring which is located in the up-and-down outermost layer according to the multilayer-interconnection substrate 11 with a built-in capacitor element of this invention -- vertical both the principal planes of a capacitor element 5 -- setting -- pulling out -- the polar zone 4 -- penetration, since it was made to connect with the connection pad 9 electrically through a conductor 8 and becomes possible to connect an external electrical circuit with a capacitor element 5 electrically by the minimum distance The inductance resulting from the die length of wiring can be reduced, and the effectiveness of noise reduction can consider as the large multilayer-interconnection substrate 11 with a built-in capacitor element.

[0054] In addition, although the multilayer-interconnection substrate 11 with a built-in capacitor element of this invention manufactured the multilayer-interconnection substrate 11 with a built-in capacitor element by carrying out the

laminating of the insulating layer 6 of four layers in the above-mentioned example possible as for various modification when it was range which is not limited to an above-mentioned example and does not deviate from the summary of this invention, it may carry out the laminating of two-layer or the insulating layer 6 of three layers or five layers or more, and may manufacture the multilayer-interconnection substrate 11 with a built-in capacitor. Moreover, although the insulating layer 6 containing a capacitor element 5 was made into one layer in the above-mentioned example, it is good also as more than two-layer (a continuation layer is included). Furthermore, the two or more number per electrode of the drawer polar zone 4 formed in the capacitor element 5 may be formed.

[0055]

[Effect of the Invention] Since it shall have the drawer polar zone which the through tube which penetrates a capacitor element perpendicularly to many electrode layers is filled up with a conductor, and changes according to the capacitor element of this invention, and a diameter can form easily the detailed drawer polar zone of several 10 micrometers, without printing an end-face electrode and a surface electrode to a capacitor element, it can miniaturize. Moreover, since had to take about an electrode, it did not have to be carried out [the end-face electrode and the surface electrode could be arranged in the capacitor element,], it could pull out by the minimum distance right above [of an electrode layer] and the polar zone was formed, it should be possible to have made small the inductance component resulting from the die length of a leading-about electrode, and it should excel in the electrical property with few power-source noises also in the RF field. Furthermore, since the drawer polar zone has projected on the outside of the principal plane of a capacitor element according to the capacitor element of this invention When a capacitor element is built in a multilayer-interconnection substrate and a multilayer-interconnection substrate with a built-in capacitor element is manufactured, it sets at the pressurization process. It becomes possible to raise pack density. the penetration which was

projected on the outside of the principal plane of a capacitor element and to which it pulled out and the polar zone was formed in the insulating layer -- a conductor -- pressurizing -- penetration -- the conductor of a conductor -- penetration -- the electric resistance of a conductor is decreased -- it can make -- consequently, penetration -- the inductance component of a conductor can be made small, there is little generating of a noise, and electronic equipment, such as communication equipment, is not made to generate malfunction

[0056] moreover, from having built the above-mentioned capacitor element in the interior of the cavernous section which the insulating layer was further alike at least, and was prepared according to the multilayer-interconnection substrate with a built-in capacitor element of this invention Since a capacitor element haves to arrange neither an end-face electrode nor a surface electrode like the conventional capacitor element and does not have to take about and carry out an electrode It becomes possible to realize low inductance-ization from the multilayer-interconnection substrate which contained the conventional capacitor element, and there is little generating of a noise and it can consider as the multilayer-interconnection substrate with a built-in capacitor element which does not make electronic equipment, such as communication equipment, generate malfunction.

[0057] It considers as the connection pad by which some conductors are connected with an external electrical circuit. furthermore, wiring which is located in the up-and-down outermost layer according to the multilayer-interconnection substrate with a built-in capacitor element of this invention -- vertical both the principal planes of a capacitor element -- setting -- pulling out -- the polar zone -- penetration, since it was made to connect with a connection pad electrically through a conductor and becomes possible to connect an external electrical circuit with a capacitor element electrically by the minimum distance The inductance resulting from the die length of wiring can be reduced, and the effectiveness of noise reduction can consider as a large multilayer-interconnection substrate with a built-in capacitor element.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing an example of the gestalt of operation of the capacitor element of this invention.

[Drawing 2] It is the sectional view of the multilayer-interconnection substrate with a built-in capacitor element of this invention which built in the capacitor element of drawing 1 .

[Drawing 3] (a) - (g) is a sectional view for every process for explaining the manufacture approach of the multilayer-interconnection substrate with a built-in capacitor element of this invention, respectively.

[Description of Notations]

1 ..... Electrode layer
2 ..... Ceramic dielectric layer
3 ..... Through tube
4 ..... Drawer polar zone
5 ..... Capacitor element
6 ..... Insulating layer
7 ..... wiring -- a conductor

8 ..... penetration -- a conductor

9 ..... Connection pad

10 ..... Cavernous section

11 ..... Multilayer-interconnection substrate with a built-in capacitor element

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[Translation done.]

* NOTICES *

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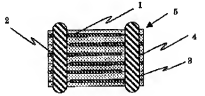
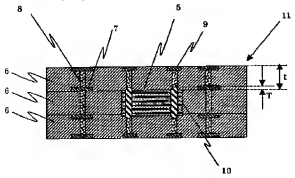
3.In the drawings, any words are not translated.

DRAWINGS

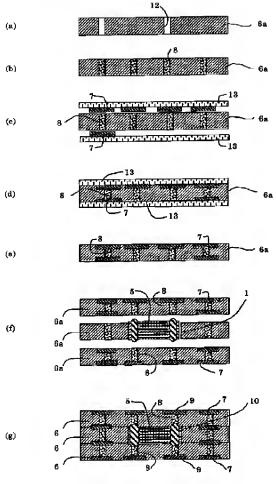
[Drawing 1]



[Drawing 2]



[Drawing 3]



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	2/06		Ｈ０５Ｋ	3/46	Ｑ	５Ｅ３４６
Ｈ０５Ｋ	3/46		Ｈ０１Ｇ	1/035	Ｄ	

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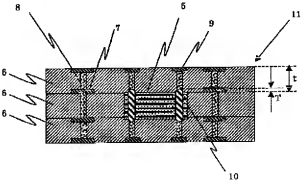
最終頁に続く

(54)【発明の名称】　コンデンサ素子およびコンデンサ素子内蔵多層配線基板

(57)【要約】
【課題】　コンデンサ素子およびコンデンサ素子内蔵多層配線基板の小型化・低インダクタンス化。
【解決手段】　多数の電極層１に対して垂直方向に貫通する複数の貫通孔３に導体が充填されて成る引き出し電極部４を有するコンデンサ素子５であって、引き出し電極部４は、コンデンサ素子５の主面の外側に突出していることを特徴とするコンデンサ素子５。およびコンデンサ素子５を内蔵し、コンデンサ素子５の上下両主面において引き出し電極部４が貫通導体８を介して接続パッド９に電気的に接続されていることを特徴とするコンデンサ素子内蔵多層配線基板11。



【特許請求の範囲】

【請求項１】　多数の電極層およびセラミック誘電体層を交互に積層して成り、前記多数の電極層に対して垂直方向に貫通する複数の貫通孔に導体が充填されて成る引き出し電極部を有するコンデンサ素子であって、前記引き出し電極部は、前記コンデンサ素子の主面の外側に突出していることを特徴とするコンデンサ素子。

【請求項２】　有機材料から成る複数の絶縁層を積層するとともにこれら絶縁層の表面に配線導体を形成し、前記絶縁層を挟んで上下に位置する前記配線導体間を前記絶縁層に形成された貫通導体を介して電気的に接続して成り、上下の最外層に位置する前記配線導体の一部が外部電気回路と接続される接続パッドとされており、前記絶縁層の少なくとも一層に設けられた空洞部の内部に請求項１記載のコンデンサ素子を内蔵するとともに、該コンデンサ素子の上下両主面において前記引き出し電極部が前記貫通導体を介して前記接続パッドに電気的に接続されていることを特徴とするコンデンサ素子内蔵多層配線基板。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、各種ＡＶ機器や家電機器・通信機器・コンピュータやその周辺機器等の電子機器に使用されるコンデンサ素子およびそれを内蔵した配線基板に関する。

【０００２】

【従来の技術】従来、配線基板は、アルミナ等のセラミック材料から成る絶縁層あるいはガラスエポキシ樹脂等の有機樹脂材料から成る絶縁層の内部および表面に複数の配線導体を形成し、上下に位置する配線導体間を絶縁層に形成した貫通導体を介して電気的に接続して成り、この配線基板の表面に半導体素子やコンデンサ・抵抗素子等の電子素子を搭載取着するとともにこれらの電極を各配線導体に接続することによって電子機器に使用される電子装置が形成されている。

【０００３】しかしながら、近年、電子機器は、移動体通信機器に代表されるように小型・薄型・軽量化が要求されてきており、このような電子機器に搭載される配線基板も小型・高密度化が要求されるようになってきている。

【０００４】このような要求に対応するために、特開平11-220262号公報には、配線基板の表面に搭載される電子素子の数を減らして配線基板を小型化する目的で、配線基板の内部にチップ状コンデンサ素子を実装することが提案されている。

【０００５】

【発明が解決しようとする課題】近年、電子機器のさらなる小型化が要求される中で、配線基板の小型化とともに配線基板に内蔵されるコンデンサ素子もより小型化が要求されるようになってきている。

【０００６】しかしながら、特開平11-220262号公報に示されるようなチップ状コンデンサ素子を配線基板に内蔵して配線基板内部の配線導体あるいは貫通導体と電気的な接続を行うためには、コンデンサ素子の上面および／または下面に半田や導電性ペーストから成る表面電極をスクリーン印刷法等の方法によって形成する必要があるが、コンデンサ素子の小型化にともない微細な表面電極を形成することが困難と成り、配線基板内蔵用のコンデンサ素子の小型化が困難であるという問題点を有していた。

【０００７】さらに、近年、通信速度の高速化に伴い通信機器等の電子機器類は周波数が数100ＭＨｚ以上の高周波領域で使用されるようになってきており、このような高周波領域においてはコンデンサ素子の電極と半導体素子等の電子部品とをつなぐ配線導体の長さに起因するインダクタンス成分が無視できなくなってきている。このため、配線基板にチップ状コンデンサ素子を内蔵した場合、コンデンサ素子の各電極層からコンデンサ素子側面の端面電極への電極引き出し、さらにはコンデンサ素子の上面および／あるいは下面への電極引き出しといった電極の引き回しがあるため、引き回し電極の長さに起因するインダクタンス成分が大きなものとなり、ΔＶ＝Ｌ・ｄＩ／ｄｔ（ΔＶは電源ノイズ、Ｌはインダクタンス、Ｉは電流値、ｔは時間）で定義されるインダクタンス成分により発生する電源ノイズΔＶが無視できないほど大きくなってしまい、通信機器等の電子機器類に誤動作を発生させてしまう等の問題点を有していた。

【０００８】本発明は、かかる従来技術の問題点に鑑み案出されたものであり、その目的は、ノイズの発生が少なく、通信機器等の電子機器類に誤動作を発生させてしまうことのない小型のコンデンサ素子およびコンデンサ素子内蔵多層配線基板を提供することにある。

【０００９】

【課題を解決するための手段】本発明のコンデンサ素子は、多数の電極層およびセラミック誘電体層を交互に積層して成り、多数の電極層に対して垂直方向に貫通する複数の貫通孔に導体が充填されて成る引き出し電極部を有するコンデンサ素子であって、引き出し電極部は、このコンデンサ素子の主面の外側に突出していることを特徴とするものである。

【００１０】また、本発明のコンデンサ素子内蔵多層配線基板は、有機材料から成る複数の絶縁層を積層するとともにこれら絶縁層の表面に配線導体を形成し、絶縁層を挟んで上下に位置する配線導体間を絶縁層に形成された貫通導体を介して電気的に接続して成り、上下の最外層に位置する配線導体の一部が外部電気回路と接続される接続パッドとされており、絶縁層の少なくとも一層に設けられた空洞部の内部に上記のコンデンサ素子を内蔵するとともに、このコンデンサ素子の上下両主面において引き出し電極部が貫通導体を介して接続パッドに電気

的に接続されていることを特徴とするものである。

【0011】本発明のコンデンサ素子によれば、コンデンサ素子を多数の電極層に対して垂直方向に貫通する貫通孔に導体が充填されて成る引き出し電極部を有するものとしたので、コンデンサ素子に端面電極や表面電極を印刷することなく直径が数10μmという微細な引き出し電極部を容易に形成することができるために小型化することができる。また、コンデンサ素子に端面電極や表面電極を配設して電極を引き回しする必要もなく電極層の直上に最短距離で引き出し電極部を形成することができるので、引き回し電極の長さに起因するインダクタンス成分を小さくすることが可能で、高周波領域においても電源ノイズの少ない電気特性に優れたものとすることができる。さらに、本発明のコンデンサ素子によれば、引き出し電極部がコンデンサ素子の主面の外側に突出しているので、コンデンサ素子を多層配線基板に内蔵してコンデンサ素子内蔵多層配線基板を製作した場合、その加圧工程において、コンデンサ素子の主面の外側に突出した引き出し電極部が絶縁層に形成された貫通導体を加圧して貫通導体の導体充填密度を上げることが可能となり、貫通導体の電気抵抗を減少させることができ、その結果、貫通導体のインダクタンス成分を小さくすることができ、ノイズの発生が少なく、通信機器等の電子機器類に誤動作を発生させることがない。

【0012】また、本発明のコンデンサ素子内蔵多層配線基板によれば、絶縁層の少なくとも一層に設けられた空洞部の内部に上記のコンデンサ素子を内蔵したことから、コンデンサ素子が従来のコンデンサ素子のように端面電極や表面電極を配設して電極を引き回しする必要がないので、従来のコンデンサ素子を内蔵した多層配線基板よりも低インダクタンス化を実現することが可能となり、ノイズの発生が少なく、通信機器等の電子機器類に誤動作を発生させてしまうことのないコンデンサ素子内蔵多層配線基板とすることができる。

【0013】さらに、本発明のコンデンサ素子内蔵多層配線基板によれば、上下の最外層に位置する配線導体の一部を外部電気回路と接続される接続パッドとし、コンデンサ素子の上下両主面において引き出し電極部を貫通導体を介して接続パッドに電気的に接続させたことから、最短距離でコンデンサ素子と外部電気回路を電気的に接続することが可能となるため、配線の長さに起因するインダクタンスを低減でき、ノイズ低減の効果が大きいコンデンサ素子内蔵多層配線基板とすることができる。

【0014】

【発明の実施の形態】次に本発明のコンデンサ素子およびコンデンサ素子内蔵多層配線基板を添付の図面に基づいて詳細に説明する。

【0015】図1は、本発明のコンデンサ素子の実施の形態の一例を示す断面図である。また、図2は、図1のコンデンサ素子を内蔵した本発明のコンデンサ素子内蔵多層配線基板の断面図であり、本例では、コンデンサ素子を1個内蔵した場合を示している。これらの図において、1は電極層、2はセラミック誘電体層、3は貫通孔、4は引き出し電極部で、主にこれらで本発明のコンデンサ素子5が構成されている。また、6は絶縁層、7は配線導体、8は貫通導体、9は接続パッドで、主にこれらとコンデンサ素子5とで本発明のコンデンサ素子内蔵多層配線基板11が構成されている。なお、図2には、絶縁層6を3層積層して成るコンデンサ素子内蔵多層配線基板11を示している。また、コンデンサ素子内蔵多層配線基板11は内部に位置する絶縁層6の少なくとも1層には空洞部10が形成されており、その空洞部10にはコンデンサ素子5が埋設されている。

【0016】コンデンサ素子5は、縦・横・高さがそれぞれ0.3～5mmの直方体であり、図1に断面図で示すように、セラミック誘電体層2と電極層1とを交互に積層することにより形成されている。

【0017】このようなセラミック誘電体層2の材料としては、種々の誘電体セラミック材料を用いることができ、例えば、$BaTiO_3$や$LaTiO_3$・$CaTiO_3$・$SrTiO_3$等のセラミック組成物、あるいは、$BaTiO_3$の構成元素であるBaをCaで、TiをZrやSnで部分的に置換した固溶体等のチタン酸バリウム系材料や、鉛系ペロブスカイト型構造化合物等が挙げられる。

【0018】また、電極層1を形成する材料としては、例えばPdやAg・Pt・Ni・Cu・Pb等の金属やそれらの合金が用いられる。

【0019】さらに、コンデンサ素子5は、多数の電極層1に対して垂直方向に貫通する貫通孔3に導体が充填されて成る引き出し電極部4を有している。

【0020】本発明のコンデンサ素子5によれば、コンデンサ素子5を、多数の電極層1に対して垂直方向に貫通する貫通孔3に導体が充填されて成る引き出し電極部4を有するものとしたことから、コンデンサ素子5に端面電極や表面電極を印刷することなく直径が数10μmという微細な引き出し電極部4を容易に形成することができるためコンデンサ素子5を小型化することができるとともに、コンデンサ素子5に端面電極や表面電極を配設して電極を引き回しする必要もなく、電極層1の直上に最短距離で引き出し電極部4を形成することができるので、引き回し電極の長さに起因するインダクタンス成分を小さくすることが可能で、高周波領域においても電源ノイズの小さい電気特性に優れたものとすることができる。

【0021】なお、引き出し電極部4の数は4～50個であり、これらは第1引き出し電極部と第2引き出し部とに分類される。そして、コンデンサ素子5を構成する電極層1も、第1電極層と第2電極層とに分類され、第1

電極層は第1引き出し電極によって電気的に接続されている。また、第2電極層は第2引き出し電極によって電気的に接続されており、セラミック誘電体層2を介して第1電極層と対向するように配置される。

【0022】このような、引き出し電極部4は、その個数が4個未満であるとインダクタンスを低減する効果が小さくなる傾向があり、50個を超えると電極層1の面積が小さくなってコンデンサ素子5の容量が小さくなってしまう傾向がある。

【0023】また、引き出し電極部4の配置は、第1引き出し電極部と第2引き出し電極部が隣り合うようにすることがインダクタンスを低減するために重要であり、第1引き出し電極部と第2引き出し電極部が、格子状の配列の隣接する格子点にそれぞれ位置するように配置すると、よりインダクタンスを低減することができ好ましい。

【0024】さらに、隣接する引き出し電極部4同士の間隔は50～400μmである。50μmよりも小さいと導電ペーストを充填する際にショートする危険性があり、400μmよりも大きいとインダクタンス低減の効果が小さくなる傾向がある。

【0025】このようなコンデンサ素子5に形成される貫通孔3は、電極層1とセラミック誘電体層2とから成る積層体に、パンチングによる打ち抜き加工やUV－YAGレーザやエキシマレーザ・炭酸ガスレーザ等によるレーザ穿設加工等の方法により形成され、特に微細な貫通孔3とするためには、レーザによる穿設加工により形成されることが好ましい。また、貫通孔3の径は数10μm～数mmであり、コンデンサ素子5の大きさにあわせて適宜決めればよい。

【0026】なお、貫通孔3は、内部に充填される導体と電極層1との電気的接続を良好にするために、打ち抜き加工やレーザ穿設加工後に超音波洗浄処理やデスミア処理等を施しても良い。

【0027】また、貫通孔3に充填される導体としては、PdやAg・Pt・Ni・Cu・Pb等の金属やそれらの合金が用いられ、特に電極層1との電気的接続を良好にするという観点からは、電極層1と同じ材質のものを含有することが好ましい。

【0028】このような貫通孔3に充填される導体は、有機溶剤に有機バインダ樹脂を溶解させた有機ビヒクル中に金属粉末を分散させて成る導電ペーストを貫通孔3にスクリーン印刷法等の方法で充填することにより形成される。なお、ビヒクル中には、これらの他、各種分散剤・活性剤・可塑剤などが必要に応じて添加されても良い。

【0029】また、導電ペーストに用いられる有機バインダ樹脂は、金属粉末を均質に分散させるとともに貫通孔3への埋め込みに適正な粘度とレオロジーを与える役割をもっており、例えば、アクリル樹脂やフェノール樹脂・アルキッド樹脂・ロジンエステル・エチルセルロース・メチルセルロース・PVA(ポリビニルアルコール)・ポリビニルブチラール等が挙げられる。特に、金属粉末の分散性を良くするという観点からは、アクリル樹脂を用いることが好ましい。

【0030】さらに、導電ペーストに用いられる有機溶剤は、有機バインダ樹脂を溶解して金属粉末粒子を分散させ、このような混合系全体をペースト状にする役割をなし、例えば、α-テルピネオール やベンジルアルコール等のアルコール系や炭化水素系・エーテル系・BCA(ブチルカルビトールアセテート)等のエステル系・ナフサ等が用いられ、特に、金属粉末の分散性を良くするという観点からは、α-テルピネオール等のアルコール系溶剤を用いることが好ましい。

【0031】さらにまた、導電ペーストは、埋め込み・焼成後のコンデンサ磁器への接着強度を上げるために、ガラスフリットやセラミックフリットを加えたペーストとすることができる。この場合のガラスフリットやセラミックフリットとしては特に限定されるものではなく、例えば、ホウ珪酸塩系やホウ珪酸亜鉛系のガラス、あるいは、チタニア・チタン酸バリウムなどのチタン系酸化物などを適宜用いることができる。

【0032】このようなコンデンサ素子5は、次の方法により製作される。

【0033】まず、周知のシート成形法により作成されたセラミック誘電体層2と成る、例えば$BaTiO_3$誘電体セラミックグリーンシート表面に、周知のペースト作成法により作成したNi金属ペーストをスクリーン印刷法により所定形状と成るように印刷して未焼成電極層を形成し、続いてこれらを所定順序に積層し、圧着して積層体を得る。そして、この積層体にレーザにより所定の位置に複数の貫通孔3を形成後、超音波洗浄により貫通孔3を水洗し、この貫通孔3に例えばNi金属粉末とアクリル樹脂とα-テルピネオールとから成る導電ペーストをスクリーン印刷法により充填する。しかる後、これらを800～1600℃の温度で焼成することにより製作される。

【0034】なお、貫通孔3に充填された導体は、焼成後有機バインダ樹脂や溶剤が除去され、引き出し電極部4と成る。

【0035】また、本発明では、この引き出し電極部4はコンデンサ素子5の主面の外側に突出していることを特徴とするものであり、本発明においてはこのことが重要である。

【0036】本発明のコンデンサ素子5によれば、コンデンサ素子5主面に引き出し電極部4を突出させたことから、コンデンサ素子5を多層配線基板に内蔵してコンデンサ素子内蔵多層配線基板11を製作した場合、コンデンサ素子内蔵多層配線基板11作製時の加圧工程において絶縁層6に形成された貫通導体8に均一に圧力がかこ

とにより、貫通導体８の導体充填密度を上げることが可能となり、電気抵抗を減少させることができ、その結果、貫通導体８のインダクタンス成分を小さくすることができ、ノイズの発生が少なく、通信機器等の電子機器類に誤動作を発生させてしまうことがない。

【００３７】このような引き出し電極部４は、コンデンサ素子５の主面の外側に突出した部分の高さＴが、絶縁層６の厚さをｔとした時に0.1ｔ～0.5ｔの範囲とすることが好ましい。突出した引き出し電極部４の高さＴが0.1ｔ未満であると、貫通導体８に十分な圧力がかかるないため導体充填密度を上げる効果が小さくなり、貫通導体８のインダクタンスが大きくなる傾向にある。また、0.5ｔを超えると、絶縁層６を積層して加圧する際に、貫通導体８に圧力がかかりすぎて、コンデンサ内蔵多層基板11に反りが発生する傾向がある。従って、コンデンサ素子５の主面の外側に突出させた引き出し電極部４の突出部の高さＴは、絶縁層６の厚さをｔとした時に0.1ｔ～0.5ｔの範囲が好ましい。

【００３８】また、コンデンサ素子５主面の外側に突出した引き出し電極部４の絶縁層６に平行な方向の断面の直径は、絶縁層６に形成した貫通導体８の直径よりも大きいことが好ましい。貫通導体８の直径よりも大きくすることにより、絶縁層６を積層して加圧した際に貫通導体８に均一に圧力がかかるため、貫通導体８の密度が上がり電気抵抗を減少させることができる。

【００３９】このようなコンデンサ素子５の主面の外側に引き出し電極部４を突出させる方法として、セラミック誘電体層２と成る焼成前のセラミックグリーンシート積層体に貫通孔３を形成し、この貫通孔３内に金属導体を充填して引き出し電極部４を形成した後、これらを焼成する前に、引き出し電極部４以外のセラミックグリーンシート積層体の表面部分をブラシ研磨による粗化処理を施すことにより、あるいは、セラミックグリーンシート積層体表面にレーザを照射してセラミックグリーンシート表面の一部を除去することにより引き出し電極部４を突出させることができる。あるいは、セラミックグリーンシート積層体に貫通孔３を形成した後、セラミックグリーンシート表面に貫通孔３の部分が開口された所望の厚みを有するマスクを置いてその上からスキージ等を用いて貫通孔３に金属導体を充填することにより、マスクの厚みに相当する引き出し電極部４を突出させ、これらを最終的に焼成することにより形成してもよい。さらに、セラミックグリーンシート積層体表面に樹脂フィルム等の保護膜を貼り付けた後、貫通孔３を形成し、この貫通孔３に保護膜上から金属導体を充填し、しかる後、保護膜を剥ぎ取り、あるいは、保護膜を付けたまま焼成することにより形成することもできる。さらにまた、焼成後のコンデンサ素子５の表面のセラミック誘電体層２部分をエッチングなどの化学的手法により取り除き、引き出し電気極部４を突出させてもよい。

【００４０】なお、引き出し電極部４の突出部の形状は、絶縁層６に垂直な方向の断面が半円形や多角形、または先端部が尖った三角形でも良いが、引き出し電極部４の先端部と貫通導体８の接触面積を増加させて、絶縁層６とコンデンサ素子５との密着を強固なものとするという観点からは、引き出し電極部４の断面形状は半円形であることが望ましい。このような半円形とすることにより、突出した引き出し電極部４と貫通導体８との接触面積が増加し、その結果、コンデンサ素子５が貫通導体８に拘束されることにより、引き出し電極部４と貫通導体８との間で剥離して断線してしまうこともない。

【００４１】このような引き出し電極部４の突出部の形をコントロールする方法としては、セラミックグリーンシート積層体に貫通孔３を形成し、貫通孔３に金属導体を充填する際のマスクの形状を調整したり、あるいは、焼成後のセラミック誘電体層２の突出部表面を研磨することで調整することができる。

【００４２】次に、本発明のコンデンサ素子内蔵多層配線基板11を、図２および図３に基づいて詳細に説明する。なお、図３（ａ）～（ｇ）は、図２のコンデンサ素子内蔵多層配線基板11を製作するための工程毎の断面図である。

【００４３】まず、図３（ａ）に断面図で示すように、絶縁層６と成る未硬化の前駆体シート６ａを準備し、この前駆体シート６ａにレーザ加工により所望の個所に直径が17～150μｍ程度の貫通孔12を穿設する。

【００４４】未硬化の前駆体シート６ａは、エポキシ樹脂やビスマレイミドトリアジン樹脂・熱硬化性ポリフェニレンエーテル樹脂・液晶ポリマー樹脂等の有機樹脂材料から成り、機械的強度を向上させるためのシラン系やチタネート系等のカップリング剤、熱安定性を改善するための酸化防止剤や耐光性を改善するための紫外線吸収剤等の光安定剤、難燃性を改善するためのハロゲン系もしくはリン酸系の難燃性剤、アンチモン系化合物やホウ酸亜鉛・メタホウ酸バリウム・酸化ジルコニウム等の難燃助剤、潤滑性を改善するための高級脂肪酸や高級脂肪酸エステル・高級脂肪酸金属塩・フルオロカーボン系界面活性剤等の滑剤、熱膨張係数を調整するためおよび／または機械的強度を向上させるための酸化アルミニウム・酸化珪素・酸化チタン・酸化バリウム・酸化ストロンチウム・酸化ジルコニウム・酸化カルシウム・ゼオライト・窒化珪素・窒化アルミニウム・炭化珪素・ホウ酸アルミニウム・スズ酸バリウム・ジルコン酸バリウム・ジルコン酸ストロンチウム等の充填材、あるいは、繊維状ガラスを布状に織り込んだガラスクロス等や耐熱性有機樹脂繊維から成る不織布等の基材を含有させてもよい。

【００４５】このような前駆体シート６ａは、例えば、絶縁材料として熱硬化性樹脂と無機絶縁粉末との複合材料を用いる場合、以下の方法によって製作される。まず、前述した無機絶縁粉末に熱硬化性樹脂を無機絶縁粉

末量が17～80体積％となるように溶媒とともに加えた混合物を得、この混合物を混練機（ニーダ）や３本ロール等の手段によって混合してペーストを製作する。そして、このペーストを圧延法や押し出し法・射出法・ドクターブレード法などのシート成形法を採用してシート状に成形した後、熱硬化性樹脂が完全硬化しない温度に加熱して乾燥することにより絶縁層６となる前駆体シート６ａが製作される。なお、ペーストは、好適には、熱硬化性樹脂と無機絶縁粉末との複合材料に、トルエン・酢酸ブチル・メチルエチルケトン・メタノール・メチルセロソルブアセテート・イソプロピルアルコール・メチルイソブチルケトン・ジメチルホルムアミド等の溶媒を添加してなる所定の粘度を有する流動体であり、その粘度は、シート成形法にもよるが100～3000ポイズが好ましい。

【００４６】次に、図３（ｂ）に断面図で示すように、貴通孔12内に銅・銀・金・半田等から成る導電性ペーストを従来周知のスクリーン印刷法等を採用して充填し、貫通導体８を形成する。

【００４７】次に、図３（ｃ）に断面図で示すように、前駆体シートの表面と裏面とに被着する配線導体７を準備する。そして、図３（ｄ）に断面図で示すように、配線導体７を前駆体シートの表面および裏面に、必要な配線導体７と貫通導体８とが電気的に接続するように重ね合わせて転写する。

【００４８】なお、本実施例では、配線導体７の形成を転写法によって行っており、このような配線導体７は、次に述べる方法により形成される。まず、離型シート等の支持体13の表面に銅・金・銀・アルミニウム等から選ばれる１種または２種以上の合金からなる厚さ１～35μｍの金属箔を接着し、その表面に所望の配線パターンの鏡像パターンとなるようにレジスト層を形成した後、エッチング・レジスト除去によって所定の配線パターンの鏡像の配線導体７を形成する。次に、配線導体７の前駆体シート６ａの表面および裏面への被着は、配線導体７が形成された支持体13を前駆体シート６ａの表面および裏面へ重ね合わせ、しかる後、圧力が0.5～10ＭＰａ、温度が60～150℃の条件で加圧加熱した後、支持体13を剥がすことにより、図３（ｅ）に断面図に示すように配線導体７が前駆体シートに被着される。なお、この時、貫通導体８は、完全に硬化していない未硬化状態としておくことが重要である。

【００４９】また、支持体13としては、ポリエチレンテレフタレートやポリエチレンナフタレート・ポリイミド・ポリフェニレンサルファイド・塩化ビニル・ポリプロピレン等公知のものが使用できる。支持体13の厚みは10～100μｍが適当であり、望ましくは25～50μｍが良い。支持体13の厚みが10μｍ未満であると支持体13の変形や折れ曲がりにより形成した配線導体７が断線し易くなり、厚みが100μｍを超えると支持体13の柔軟性がなくなって、前駆体シートからの支持体13の剥離が困難となる傾向がある。また、支持体13表面に電解金属箔を形成するために、アクリル系やゴム系・シリコン系・エポキシ系等公知の接着剤を使用してもよい。

【００５０】そして、図３（ｆ）に断面図で示すように、上記(a)～(f)の工程を経て製作した複数の前駆体シート６ａと、コンデンサ素子５とを準備し、次に、引き出し電極部４の先端部と貫通導体８との位置合わせを行い載置するとともに前駆体シートを積層し、温度が150～300℃、圧力が0.5～10ＭＰａの条件で30分～24時間ホットプレスして前駆体シートおよび導電性ペーストを完全硬化させることによって、図３（ｇ）に断面図で示す本発明のコンデンサ素子内蔵多層配線基板11が完成する。

【００５１】なお、コンデンサ素子５を収容する空洞部10は、前駆体シート６ａを積層する前に、前駆体シート６ａのコンデンサ素子５が収容される個所にレーザ法やパンチング法により穿設しておけばよい。

【００５２】かくして本発明のコンデンサ素子内蔵多層配線基板11によれば、絶縁層６の少なくとも一層に設けられた空洞部10の内部に上記のコンデンサ素子５を内蔵したことから、従来の場面に電極が印刷されたコンデンサ素子を内蔵した多層配線基板よりも低インダクタンス化を実現することが可能となり、ノイズの発生が少なく、通信機器等の電子機器類に誤動作を発生させてしまうことのないコンデンサ素子内蔵多層配線基板11とすることができる。

【００５３】また、本発明のコンデンサ素子内蔵多層配線基板11によれば、上下の最外層に位置する配線導体７の一部を外部電気回路と接続される接続パッド９とし、コンデンサ素子５の上下両主面において引き出し電極部４を貫通導体８を介して接続パッド９に電気的に接続させたことから、最短距離でコンデンサ素子５と外部電気回路を電気的に接続することが可能となるため、配線の長さに起因するインダクタンスを低減でき、ノイズ低減の効果が大きいコンデンサ素子内蔵多層配線基板11とすることができる。

【００５４】なお、本発明のコンデンサ素子内蔵多層配線基板11は上述の実施例に限定されるものではなく、本発明の要旨を逸脱しない範囲であれば種々の変更は可能であり、例えば、上述の実施例では４層の絶縁層６を積層することによってコンデンサ素子内蔵多層配線基板11を製作したが、２層や３層あるいは５層以上の絶縁層６を積層してコンデンサ内蔵多層配線基板11を製作してもよい。また、上述の実施例ではコンデンサ素子５を含む絶縁層６を１層としたが、２層（連続層を含む）以上としてもよい。さらに、コンデンサ素子５に形成した引き出し電極部４の数は一つの電極につき２個以上形成してもよい。

【００５５】

【発明の効果】本発明のコンデンサ素子によれば、コンデンサ素子を多数の電極層に対して垂直方向に貫通する貫通孔に導体が充填されて成る引き出し電極部を有するものとしたので、コンデンサ素子に端面電極や表面電極を印刷することなく直径が数10μmという微細な引き出し電極部を容易に形成することができるために小型化することができる。また、コンデンサ素子に端面電極や表面電極を配設して電極を引き回しする必要もなく電極層の直上に最短距離で引き出し電極部を形成することができるので、引き回し電極の長さに起因するインダクタンス成分を小さくすることが可能で、高周波領域においても電源ノイズの少ない電気特性に優れたものとすることができる。さらに、本発明のコンデンサ素子によれば、引き出し電極部がコンデンサ素子の主面の外側に突出しているので、コンデンサ素子を多層配線基板に内蔵してコンデンサ素子内蔵多層配線基板を製作した場合、その加圧工程において、コンデンサ素子の主面の外側に突出した引き出し電極部が絶縁層に形成された貫通導体を加圧して貫通導体の導体充填密度を上げることが可能となり、貫通導体の電気抵抗を減少させることができ、その結果、貫通導体のインダクタンス成分を小さくすることができ、ノイズの発生が少なく、通信機器等の電子機器類に誤動作を発生させることがない。

【００５６】また、本発明のコンデンサ素子内蔵多層配線基板によれば、絶縁層の少なくとも一層に設けられた空洞部の内部に上記のコンデンサ素子を内蔵したことから、コンデンサ素子が従来のコンデンサ素子のように端面電極や表面電極を配設して電極を引き回しする必要がないので、従来のコンデンサ素子を内蔵した多層配線基板よりも低インダクタンス化を実現することが可能となり、ノイズの発生が少なく、通信機器等の電子機器類に誤動作を発生させてしまうことのないコンデンサ素子内蔵多層配線基板とすることができる。

【００５７】さらに、本発明のコンデンサ素子内蔵多層配線基板によれば、上下の最外層に位置する配線導体の一部を外部電気回路と接続される接続パッドとし、コンデンサ素子の上下両主面において引き出し電極部を貫通導体を介して接続パッドに電気的に接続させたことから、最短距離でコンデンサ素子と外部電気回路を電気的に接続することが可能となるため、配線の長さに起因するインダクタンスを低減でき、ノイズ低減の効果が大きいコンデンサ素子内蔵多層配線基板とすることができる。

【図面の簡単な説明】

【図１】本発明のコンデンサ素子の実施の形態の一例を示す断面図である。

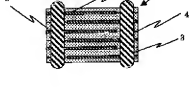
【図２】図１のコンデンサ素子を内蔵した本発明のコンデンサ素子内蔵多層配線基板の断面図である。

【図３】（ａ）～（ｇ）は、それぞれ本発明のコンデンサ素子内蔵多層配線基板の製造方法を説明するための工程毎の断面図である。

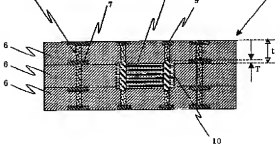
【符号の説明】

1・・・・・・・・・電極層
2・・・・・・・・・セラミック誘電体層
3・・・・・・・・・貫通孔
4・・・・・・・・・引き出し電極部
5・・・・・・・・・コンデンサ素子
6・・・・・・・・・絶縁層
7・・・・・・・・・配線導体
8・・・・・・・・・貫通導体
9・・・・・・・・・接続パッド
10・・・・・・・・・空洞部
11・・・・・・・・・コンデンサ素子内蔵多層配線基板

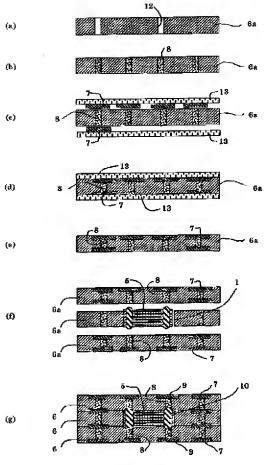
【図１】



【図２】



【図３】



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